DOCUMENT RESUME

ED 387 441 SP 036 153

AUTHOR Fuller, Roberta Ann
TITLE Change in Teachers' Conceptions and Practice.
PUB DATE 13 Oct 94
NOTE 30p.; Paper presented at the Meeting of the Mid-Western Educational Research Association (Chicago, IL, October 13, 1994). Somewhat blurred print may cause reproducibility problems.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Case Studies; Concept Formation; Elementary School Mathematics; Elementary School Teachers; Higher Education; Intermediate Grades; *Mathematical Concepts; *Mathematics Instruction; *Mathematics Teachers; *Reflective Teaching; *Teacher Improvement; *Teacher Role; Teaching Methods
IDENTIFIERS Mathematics Education Research; Reflection Process

ABSTRACT

This study examined factors that teachers say determine whether they modify new information about mathematics, mathematics learning, and mathematics teaching to fit their existing conceptions or whether they restructure their existing conceptions. Three female teachers (two sixth grade and one fifth grade) from a rural, public school participated in this study. All three teachers are currently participating in a research project which is disseminating new information about mathematics, mathematics learning, and mathematics teaching. There were no specific criteria used in the selection of the three teachers other than the fact that they had expressed an interest and willingness to participate in the study. Each teacher was observed teaching a mathematics lesson, and an interview was conducted following the observed lesson. Both the lessons and the interview sessions typically lasted one hour and were audio-recorded to secure a record for later analysis. Analysis of the interviews showed that while two teachers' existing conceptions of mathematics teaching underwent change as a result of their participation in the research project, one teacher's existing conceptions of mathematics teaching were preserved, seemingly as a result of her strongly held conceptions of mathematics and mathematics learning. The results seem to indicate that, though the role of the classroom as a learning environment and the role of reflection may be important to the change process, the role of the teacher is the most salient, since the teacher exercises considerable control over the decision of whether or not to implement change. (Contains 18 references.) (Author/ND)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED 387 441

# Change in Teachers' Conceptions and Practice

Roberta Ann Fuller

Illinois State University

Spring 1994

Paper Presented at the
Mid-Western Educational Research Association Conference
Chicago, Illinois
October 13, 1994

Running Head: TEACHERS' CONCEPTIONS AND PRACTICE

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

R. Fuller

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

BEST COPY AVAILABLE

SP036153

Abstract

The purpose of this study was to examine factors teachers say determine whether they modify new information about mathematics, mathematics learning, and mathematics teaching to fit their existing conceptions or whether they restructure their existing conceptions. Three female teachers (two sixth grade and one fifth grade) from a rural, public school participated in this study. All three teachers are currently participating in a research project which is disseminating new information about mathematics, mathematics learning, and mathematics teaching. There were no specific criteria used in the selection of the three teachers other than the fact that they had expressed an interest and willingness to participate in the study. Each teacher was observed teaching a mathematics lesson and an interview was conducted following the observed lesson. Both the lessons and the interview sessions typically lasted one hour and were audio-recorded to secure a record for later analysis. Analysis of the interviews showed that while two teachers' existing conceptions of mathematics teaching underwent change as a result of their participation in the research project, one teacher's existing conceptions of mathematics teaching were preserved seemingly as a result of her strongly held conceptions of mathematics and mathematics learning. The results seem to indicate that, though the role of the classroom as a learning environment and the role of reflection may be important to the change process, the role of the teacher is the most salient, since the teacher exercises considerable control over the decision of whether or not to implement change.

## Introduction

It has been well documented that most teacher education students, both preservice and inservice, believe that mathematics consists of facts, rules, and procedures, that learning mathematics means remembering the facts, rules, and procedures, and that teaching mathematics involves telling or showing students the facts, rules, and procedures (for a list of references see McDiarmid, 1990). In light of the current move for reform in mathematics education, many preservice and inservice teacher education programs usually attempt to explore, identify, and challenge teacher education students' beliefs by providing reasonable alternatives. Unfortunately, most teachers modify the new ideas to fit their existing conceptions instead of restructuring their existing conceptions (Doyle, 1985; Doyle & Ponder, 1977; McDiarmid, 1990; Schram, Wilcox, Lanier, Lappan, & Even, 1988; Swanson-Owens, 1985; Grimellini & Pecori, 1988). Thus it seems that perhaps teacher education needs to address not only the exploration, identification, and challenging of beliefs, but also the factors that contribute to whether or not beliefs are changed.

While both the learning-to-teach literature and the teacher-change literature seem to suggest that there are several factors which may contribute to whether teachers modify new information to fit their existing conceptions or whether they restructure their existing conceptions, four seem to be crucial to the change process. They are the role of the teacher (Cobb, Wood, & Yackel, 1990; Hall & Loucks,

1978; Lieberman & Miller, 1984; Richardson, 1990; Richardson, 1992; Wood, Cobb, & Yackel, 1991), the role of the teacher educator or staff developer (Cobb, Wood, & Yackel, 1990; Richardson, 1992; Wood, Cobb, & Yackel, 1991), the role of the classroom as a learning environment (Cobb, Wood, & Yackel, 1990; Doyle & Ponder, 1977; Wood, Cobb, & Yackel, 1991), and the role of reflection (Anning, 1988; Cobb, Wood, & Yackel, 1990; Richardson 1990; Schon, 1983; Shulman, 1986; Thompson, 1984).

## THE ROLE OF THE TEACHER

The research suggests that teachers exercise considerable control over the decision of whether and how to implement a change. Richardson (1990) claims that any change process should both acknowledge this control, and help teachers understand and be held accountable for the pedagogical and moral implications of their decisions.

Richardson (1992) discusses a new form of staff development which is framed in ways of helping teachers themselves explore their beliefs and knowledge, reconstruct their premises related to teaching and learning, and alter their practices. She claims that in order for the teachers to participate in this reconstructive process, they must acknowledge the power of their own practical reasoning and expertise, and share in the ownership of the new content that helps them reconstruct their practical knowledge.

In a landmark study of the middle 1970s (Berman & McLaughlin,

1977) important descriptions of the critical importance of collaboration, teacher participation, and the practical nature of school improvement were introduced. This study and others (Berman & McLaughlin, 1977; Lieberman & Miller, 1984; Richardson, 1992; Wood, Cobb, & Yackel, 1991) have shown that if teachers are involved as collaborators in both the identification of problem areas and the search for solutions, and if they have a sense of efficacy about their own involvement in reform efforts, reforms are more likely to be implemented and to last.

Similarly, it has been shown that if attempts to get teachers to change attend to the sorts of concerns teachers have about their own practice, they are more likely to be successful (Hall & Loucks, 1978; Wood, Cobb, & Yackel, 1991; Richardson, 1992). In fact, Cobb, Wood, and Yackel (1990) claim that teachers must see their current practice as problematic as a prerequisite mental state necessary for beneficial collaboration with researchers or staff developers.

The social context that Cobb, Wood, and Yackel (1990) mutually constructed with their project teacher during the initial sessions of their study was such that she viewed them as evaluators. In an attempt to renegotiate the social norms of the relationship, the project director initiated a dialogue about a topic within the domain of the teacher's expertise - her mathematics textbook. The teacher questioned the director's suggestion that textbook-based instruction led many children to develop detrimental concepts of place value. The

teacher referred to the ability of her students to complete textbook exercises correctly to support her claim that most of them did understand place value. The project director suggested that she conduct her own interviews with some of her students to determine whether his claims were viable or not. In the course of the interviews, she began to realize that even though she had carefully taught her students the algorithmic procedures specified in the textbook and although they could produce correct answers, they did not truly understand place value. Cobb, Wood, and Yackel state that their genuine collaboration with the project teacher began when she realized that her current instructional practices were problematic.

THE ROLE OF THE TEACHER EDUCATOR OR STAFF DEVELOPER

Richardson (1992) claims that the staff developer requires extensive knowledge of the formal content and a manner that is self-effacing. Most importantly, she claims that the staff developer must help the teacher participants to redefine the content of the staff development process to include their own practical knowledge as equally legitimate to the development of shared meaning as the staff developers' formal knowledge. Thus the staff developer plays a critical role in the process of creating and maintaining a constructivist and empowering process that has a specific content as its focus.

Cobb, Wood, and Yackel (1990) further claim that the staff developer's role is to help the teacher "develop personal,

experientially-based reasons and motivations for reorganizing classroom practice" (p. 144) rather than to show the teacher how to teach in a specified way. As a result, they do not directly try to change the manner in which teachers themselves teach. Instead, they encourage them to make their practice compatible with a constructivist view of the nature of mathematical activity and learning.

Wood, Cobb, & Yackel (1991) claim that if teachers are going to make significant changes in their ways of teaching, they will need continued support as they encounter dilemmas and conflicts and that this means finding ways to guide and support teachers as they learn in the setting of their classrooms.

## THE ROLE OF THE CLASSROOM AS A LEARNING ENVIRONMENT

Cobb, Wood, & Yackel's (1990) work with teachers is based on the assumption that beliefs and practice are dialectically related. Beliefs are expressed in practice, and problems or surprises encountered in practice give rise to opportunities to reorganize beliefs. When analyzing the project teacher's learning, Cobb, Wood, and Yackel argued that her beliefs and practices were interdependent and developed together. They claim that it is precisely because of this interdependency that her classroom was her primary learning environment.

Cobb, Wood, and Yackel began to realize that researchers construct formal models in contexts that are incompatible with those in which teachers construct the knowledge that informs their practice.

Formal models are a product of a series of abstractions and formalizations made by researchers who operate in the context of academic reasoning and attempt to satisfy the current standards of their research community. In contrast, teachers operate in the context of pragmatic pedagogical problem solving in which they have to make on the spot decisions as they interact with their students in specific situations.

This context is what Doyle and Ponder (1977) refer to as the practicality ethic. The essential features of this ethic are summarized as follows. "Teachers receive a variety of messages intended to modify and improve their performance. If one listens carefully to the way teachers talk about these messages, it soon becomes clear that the term 'practical' is used frequently and consistently to label statements about classroom practices. The labeling represents an evaluative process which is a central ingredient in the initial decision teachers make regarding the implementation of a proposed change in classroom procedure. Messages which are seen as practical will be incorporated into teacher plans." (p. 2) The study of the practicality ethic, then, is the study of perceived attributes of messages and the way in which these perceptions determine the extent to which teachers will attempt to modify classroom practices.

To qualify minimally as practical, a change proposal must describe a procedure in terms which depict classroom contingencies.

This alone, however, does not determine practicality. Teachers also make decisions in terms of the extent to which a proposed procedure is congruent with perceptions of their own situations. The final criterion of practicality is described by Doyle and Ponder (1977) as cost. It refers primarily to the ease with which a procedure can be implemented and the potential return for adopting an innovation.

## THE ROLE OF REFLECTION

Recall that Wood, Cobb, & Yackel (1991) examined a teacher's learning in the setting of the classroom. The teacher changed in her beliefs about learning, teaching, and the nature of mathematics and developed a form of practice compatible with constructivism. These alterations occurred as she reflected on and resolved conflicts and dilemmas that arose between her previously established form of practice and the emphasis of the project on children's construction of mathematical meaning.

Schon (1982), Shulman (1986), and Anning (1988) claim that classroom experience is educative only with reflection and that this suggests that the improvement of the teacher-learning process requires acknowledging and building upon teachers' experiences, and promoting reflection on those experiences.

Richardson (1990) further claims that taking control of one's justifications involves reflection on practices, that is on activities and their theoretical frameworks, and an ability to articulate them to others in a meaningful way. A new classroom activity should be

introduced to teachers with an opportunity for them to relate the activity's theoretical framework to their own beliefs and understandings. She claims that empowerment is threatened when teachers are asked to make changes in activities without being asked to examine their theoretical frameworks, and that in fact, teacher empowerment does not occur without reflection and the development of the means to express justifications.

Improvement of the teacher-learning process may also require promoting reflection on beliefs. Thompson (1984) found that differences in teachers' awareness of the relationships between their beliefs and their practice seemed to be related directly to differences in their reflectiveness - in their tendency to think about their actions in relation to their beliefs. As a result of a failure to reflect on actions in relation to beliefs, and in the face of other pressures, beliefs seem to have little effect on teaching.

From this literature, it appears that factors to be considered in determining whether teachers modify new information to fit their existing conceptions or whether they restructure their existing conceptions might include the role of the teacher, the role of teacher educator or staff developer, the role of the classroom as a learning environment, and the role of reflection. However, these have not been studied directly, but have simply been discussed as characteristics of successful staff development programs. The teachers involved were never interviewed.

The purpose of this study was to examine factors teachers say determine whether they modify new information about mathematics, mathematics learning, and mathematics teaching to fit their existing conceptions or whether they restructure their existing conceptions.

## Method

The method of inquiry used was the grounded theory method (see Strauss & Corbin, 1990). Three middle school teachers participated in the study. Each teacher was observed teaching a mathematics lesson and an interview was conducted following the observed lesson. There was no time overlap among the case studies - no two were conducted simultaneously.

There were several reasons for observing the teachers prior to interviewing them. One reason was to become better acquainted with the social context before starting the more direct inquiry in the interviews. Another reason was to generate conjectures about what the teacher's conceptions might be, and thus gain a better sense of direction for later probing. This procedure allowed for inferences that led to a tentative characterization of the teacher's conceptions based only on her instruction, without direct input concerning her professed beliefs and views, and was intended to avoid the potential influence that the teacher's professed views might have on the investigator's sensitivity to the different events observed.

Both the lessons and the interview sessions typically lasted one hour and were audio-recorded to secure a record for later analysis.

## THE TEACHERS

Three female teachers (two sixth grade and one fifth grade) from a rural, public school participated in this study. All three teachers are currently participating in a research project which is disseminating new information about mathematics, mathematics learning, and mathematics teaching. There were no specific criteria used in the selection of the three teachers other than the fact that they had expressed an interest and willingness to participate in the study.

The three teachers were Rhonda, Patricia, and Carla. They had been teaching for four, seven, and eight years respectively at the same school.

### The Case Studies

What follows is a discussion of the relationships denoting causal conditions for change in or preservation of each teacher's existing conceptions of mathematics teaching, the corresponding change in or preservation of their existing teaching practices, any intervening conditions, and consequences.

## RHONDA

Rhonda's interview revealed three areas where her existing conceptions of mathematics teaching underwent change as a result of her participation in the research project. They were the use of the textbook, the use of algorithms vs. discovery, and the focus on students' thinking vs. answers.

The Use of the Textbook.

Rhonda has decided that she does not want to refer to her book as much as she did prior to participating in the project because the book "shows students exactly how to do it and they would just look in the book and do it the way the book did it and I don't want that." She now uses the book only for writing objectives and uses story problems to teach concepts. Two intervening conditions facilitated this response: a lack of direction (she "didn't know where to start" when she first attempted to implement ideas from the research project) and the perception that using the book and doing story problems were so unrelated that she could not do both.

In fact, Rhonda claims that "the big practice change is just going from doing number sentences to story problems." To do this she lets "the kids make up the story problems" or lets them choose a topic and she makes up a problem around that topic. Two intervening conditions facilitated this strategy: the project provided a "sheet that gives samples of different types of story problems" which makes "it really easy to make up story problems on the spur of the moment" and Rhonda finds it "helpful, very helpful, when we meet with our grade levels because you can hear what other kids are thinking, what other teachers have tried because sometimes I have a hard time coming up with enough story problems." Consequently, it takes longer for Rhonda to plan for mathematics since she has to make up her own tests and her own worksheets "rather than using the book's numbe

sentences," but she claims that she has "covered" over twice as much material as she did when she used the book and she believes that her students are better "prepared for real life situations."

Two intervening conditions constrained Rhonda's change in teaching practice and she responded by modifying the new information. Rhonda is "kind of worried" about her students' performance on the IGAP (Illinois Goals Assessment Program) this year for a variety of reasons ("these testings stay in their file until they graduate from high school," "it's going to influence their next year's teacher, because if they all receive low scores in math, she's going to adapt her program for low level kids," and if "the school's rankings are reported way down in math, somebody's going to be in trouble"). For this reason and because "the kids and their parents don't feel comfortable with them not knowing number sentences," she states that "what I have them do is, after they do the story problem, and I feel like they've gotten an understanding of it, I will say, 'Can you write me a number sentence that could go along with that?' Then when they've written whatever the number sentence is, I'll say, 'That is actually what you just did, so if you just see it as a number sentence somewhere, you'll have a place to start." She claims that "I've kind of adapted that because I felt it would be necessary for both the kids and myself."

One intervening condition not only constrained Rhonda's change in teaching practice, but also served as a causal condition for

preserving her existing conceptions about the use of the textbook. Because Rhonda is "having a hard time coming up with a metrics unit without going back to the book," she states that she "may refer to it quite a bit more during that time," especially since "the book does not have a bad metrics unit."

The Use of Algorithms vs. Discovery

Rhonda is now convinced "that there is more than one way to solve problems, that the algorithm is one way, not necessarily the best way, and that students must come up with their own different ways of thinking," because the project has shown videos of children solving problems using invented strategies and this has given Rhonda "the idea that if we teach a strategy, that sometimes can hurt the child and that children can discover if we let them." As a result, Rhonda now lets her students discover their own way of doing the mathematics and has them share their ideas with one another. Several intervening conditions facilitated this response: the project began to concentrate more on middle school topics and how to permit discovery at that level, Rhonda "actually got in her classroom and started trying it" with a positive reaction from the students, she therefore began to feel more "comfortable with it," and Rhonda "found out that kids can learn how to do it in their heads just as easily, and as a matter of fact more efficiently than writing it down on paper most of the time." According to Rhonda, consequences include students being convinced that there is more than one way to solve a problem, students

understanding what they are doing, and students being "able to go back to their own way of solving, because letting them discover how to solve it on their own will stick with them."

On the other hand, two intervening conditions constrained Rhonda's change in teaching practice and she responded by modifying the new information. Since Rhonda's school lacks the funds for manipulative materials, she has had to "come up with a different way" to enhance the discovery process, usually by having the students draw pictures of the manipulatives. In addition, Rhonda found that when several "kids share different ways, the other kids get bored," so she decided to use small groups instead of the whole class for sharing ideas.

One set of intervening conditions not only constrained Rhonda's change in teaching practice, but in fact served as a causal condition for preserving her existing conceptions about the use of algorithms. Rhonda struggles with "letting them discover strategies at the sixth grade level because they've already been taught a lot of algorithms and strategies and since this is the first year they've had anything to do with this program, students who have no number skills have become frustrated at times where they couldn't discover a way and had no place to even start." In this case, Rhonda tries "to give the student a place to start" and sometimes she wants "to give them something that they can use, some way that they can solve it, and that's usually the algorithm."

The Focus on Students' Thinking vs. Answers

Rhonda is convinced that teachers should focus on students' thinking in addition to the answers that they give to problems because the videos of children solving problems also "showed us how kids were thinking, which was wonderful." Therefore, Rhonda has "worked out a system" where she gives them "partial credit if they've set everything up and they're going toward the right direction, but maybe they made an addition error." The following is another strategy that Rhonda uses. "When we work in class, if we did a story problem, I'd say, 'How did you solve it? Did anybody solve it a different way?' And they explain until we've exhausted the number of ways that the kids solved it. And then I may say on the next problem, 'You can't solve it the same way you solved this one. Choose a different way."

According to Rhonda, consequences include students being able to "explain a problem," students "having to think about what they did," students understanding one anothers' solutions, teachers "seeing that students really understand what they're doing," students being helped to "do more in their heads than on paper," students becoming "confident in their own thinking," and teachers "learning from the kids, because a kid may come up with a way" that the teacher has never thought about before.

CARLA

Carla's interview also revealed three areas where her existing conceptions of mathematics teaching were changed as a result of her

participation in the research project. They too were the use of the textbook, the use of algorithms vs. discovery, and the focus on students' thinking vs. answers.

The Use of the Textbook

At the beginning of the school year, following the project's summer seminar, Carla decided that she did not want to use the book as often as she did prior to participating in the project, because she "felt [that] what the program [was] trying to get across was a good idea." She claims that it "does make sense. We just teach out of the book and we expect [the students] to know it and if they don't, well we work with them and work with them until we think they know it and some kids don't and so they just get pushed to the side." At that time, Carla primarily used the book "to pull out the concepts." Three intervening conditions facilitated this response: "being able to talk to other teachers when [she] got with [her grade level] group," "having Rhonda right next door who's in the project," and the realization that "there's other resources out there to help you . . . not just . . . the book."

Nevertheless, several intervening conditions not only constrained Carla's change in teaching practice, but also served as causal conditions for preserving her existing conceptions about the use of the textbook. According to Carla, "it takes a lot more time" to adapt to this new way of thinking than what she thought at the beginning. She "think[s] that the teacher just need[s] time to organize [his or

her] thoughts and to plan." Carla is also "concern[ed] . . about next year when [her students] have to go flying back into the book." Finally, but perhaps most importantly, Carla states that "it was very difficult," not only for her but for her students as well, because "students, especially at sixth grade who have really stayed in the book for the last five years, . . . rely on more structure than this type of project [provides]." In fact, Carla claims that her students "can't handle that loose structure" and that even she "can't handle it." As a result, Carla has "since the beginning of the year gone back in the book a lot more," because her students "feel more comfortable with it [and she] feel[s] more comfortable." Carla claims that her students "really like that feeling that they can bring their book and open it up and have something there." She "think[s] that using their textbooks is a big security blanket for them." When asked specifically what influenced her to decide to return to her previous practice, Carla stated,

> because I wasn't comfortable standing up in front of the class all day long doing problem solving. Especially at sixth grade. They're not going to want me up there for an hour every day the whole time doing problem solving. And also because I feel that they wanted a worksheet on something. The students themselves. Just their reactions to the problem solving and when I would give them a worksheet they would feel relieved. They felt like it was something that they could do even though they might not still

understand it.

The Use of Algorithms vs. Discovery

Rather than simply "teaching [an] algorithm" to her students, Carla now "want[s] them to try to come up with [it] . . . to find it out themselves," because

> the results that [the project staff has] shown us . . . and things that they've talked about . . . make sense. I felt the idea behind it was . . . in the long run it's probably what we've always been trying to achieve but yet we just never knew exactly . . . It wasn't put in front of us that this is the ultimate goal we're trying to achieve with the students, . . . that they really understand what math is or how to go about getting these problems . . . that there's a reasoning behind them . . . [that] it's not just because they were taught "this is the way you do it."

As a result, Carla has "start[ed] . . . bringing in the manipulatives drawing pictures, and doing different things like that," though several intervening conditions constrained this response. First, in "trying to use [discovery] in the classroom" with her students, Carla has found that it is "hard all of a sudden just to stop what they're doing and start going back to the basics," because "at this level [the students] haven't been exposed to this." Carla claims that "they . . think . . ." that way . . . when they're at first grade until they start learning the algorithm [and] then they start relying on it and by the time they're at sixth grade they know that there's an algorithm

to do all of these problems." Second, Carla is "worried about next year." She "wonder[s] . . . how much reteaching [of] the algorithm[s] . . [the] math teacher [is] going to have to do to satisfy her so that the students . . . [can] do [the] types of problems . . . in the book." Finally, Carla has "had a hard time finding the right groups that work well together," since "several students . . . rely on everybody else to do all their work for them." However, as a consequence of this change in teaching practice, Carla claims that "a majority" of her students would say that "doing mathematics . . . is solving problems . . . finding different ways to solve problems," as opposed to "doing . . . algorithm type worksheets or pages out of the book."

The Focus on Students' Thinking vs. Answers

As a result of her participation in the research project, Carla is now convinced that it is important to allow students an opportunity "to share [the] ideas that [they] have in solving problems." To illustrate this she relates the following:

> You know last year when a member of the project staff came to observe me, one of my students said, "I can solve this problem a different way." And I said, "Okay, well we don't have time to discuss that today." This year I would say, "Okay, what is it?"

PATRICIA

Patricia's interview revealed two areas where her existing conceptions of mathematics teaching were preserved seemingly as a

result of her strongly held conceptions of mathematics and mathematics learning. They were the use of algorithms vs. discovery and the focus on students' thinking vs. answers.

The Use of Algorithms vs. Discovery

Patricia believes that knowing how to do a procedure is important but understanding the procedure is not. Therefore, she emphatically believes that "we do have to teach the algorithms" and is opposed to using discovery. One reason for this opposition is that if students know how to use the algorithm, teachers do not need to use discovery, as can be seen by the following comments:

> The project started out Kindergarten through third grade. Now they've expanded it to fourth through sixth grade. And we have really found a lot of frustration in that because we are getting kids who have come out of a very traditional program and now they come to fifth grade and want to start at fifth grade level type problems and go back and draw a picture of this. The kid goes, "What for? I write the number sentence. I know how to add. I know how to subtract. Why should I draw a picture?" And the idea is well, do they really understand place value. Well, maybe they don't. I don't know if I really understand place value.

> We were working the other day in the class that we went to. We had a fraction problem. Well I could figure that. I just either use the reciprocal or invert and multiply. And I don't know why

> invert and multiply, but it works. I don't really care. So then pretty soon, okay, let's take manipulatives and show this. And we were sitting there figuring and fiddling with it and pretty soon I said, wait a minute. We are not showing this problem with manipulatives. We're trying to manipulate the stuff to make the answer we know is right work. We're not helping our understanding of the problem. It was backwards. The manipulative was not helping us to solve the problem. We already had it solved.

A second reason for this opposition to discovery is that Patricia believes that "there are people that survive in this world and do very well and never have a good number sense because a lot of it is an innate ability." In this case, she believes that teachers <u>should</u> not use discovery because "if you're dealing with somebody who has a number sense problem to begin with, throwing out a bunch of stuff . . the kid becomes so involved in the process of manipulating, they forget what they're supposed to do, it's just a game."

In addition, Patricia believes that discovery <u>cannot be</u> successful and in fact, <u>is not</u> successful. She believes that "while they're sitting in your classroom, you cannot give a kid day to day living experiences" like those "outside of the classroom, where they have to use it." "When we do these discovery tasks, they don't get it." In other words, according to Patricia, students do not make the connection between the discovery task and the concept being taught.

The Focus on Students' Thinking vs. Answers

Patricia believes that answers are important but solutions are not. Therefore, Patricia believes that "we should use standards of representation that are readily acceptable." One reason for this belief is that "math is one of the things that can be a little bit concrete, the answer's right or wrong."

A second set of reasons for this belief about mathematics teaching has to do with Patricia's beliefs about the learner, as is evidenced by the following:

> My kids are very much cued into answers because I think we have been . . . we have programmed our kids to find the answer.
>
> The answer's right or wrong and I think our kids think that way because we think that way.
>
> Quite often students can't really tell you what they did and they certainly can't make that make sense to someone else.
>
> If everybody in the group got the same answer, you can pretty much bet they all solved it the same way, because they have their mathematical algorithms up here.
>
> Fifth graders are not interested in listening to everybody else. They do not want to hear the thinking process of 28 kids on one problem. They do not have the patience for that. Most times as an adult we don't know how the other person found that answer. And we don't really care.

In addition, Patricia believes that "drawing out 101 beautiful

pictures to answer a problem" is not efficient, communicative, or worthwhile.

## Discussion

It appears that because Rhonda and Carla viewed their previous practice as problematic (Cobb, Wood, & Yackel, 1990), they were able to engage in the identification of problem areas and the search for solutions (Berman & McLaughlin, 1977; Lieberman & Miller, 1984; Richardson, 1992; Wood, Cobb, & Yackel, 1991), thereby sharing in the ownership of the new content (Richardson, 1992). Though various components of project meetings were mentioned as motivations for changing conceptions and/or practice, the researcher's role in this process was not specifically addressed. For two of the three teacher-identified areas of change in conceptions of mathematics teaching, Rhonda and Carla both regarded the corresponding change in practice as "practical" (Doyle & Ponder, 1977), made the decision to implement the change, and therefore learned in the setting of their classrooms (Wood, Cobb, & Yackel, 1991). This is also true for Rhonda in relation to the proposed change in the use of the textbook. However, since this change did not fit with Carla's perceptions of her own situation (Doyle & Ponder, 1977), it was too difficult for her to implement. Perhaps this occurred only in this instance because, unlike Rhonda, Carla did not reflect on and resolve conflicts and dilemmas that arose between her previously established form of practice and the proposed change (Wood, Cobb, & Yackel, 1991). This

lack of reflection seems to have been due to time constraints.

Conversely, it appears that because Patricia does not view her current practice as problematic (Cobb, Wood, & Yackel, 1990), her existing conceptions of mathematics teaching have not changed. When asked what it would take for teachers to adapt to the pedagogy advocated by the project, she responded, "First of all it would take a commitment and a desire and it would also take the decision that it's necessary to change. And I'm not sure personally that it is."

Together these results seem to indicate that, though the role of the classroom as a learning environment and the role of reflection may be important to the change process, the role of the teacher is the most salient.

## Recommendations for Future Research

Although this study provides additional insights as to why teachers modify new information about mathematics, mathematics learning, and mathematics teaching to fit their existing conceptions or change their existing conceptions, it raises other questions. Why are some teachers more resistant to change than others, as in the case of Patricia? How do personality differences contribute to this resistance? How do differences in knowledge, whether it be content knowledge, pedagogical knowledge, or pedagogical content knowledge (Shulman, 1986), affect resistance to change? And finally, how do teachers' beliefs, views, and preferences relate to the change process?

## References

Anning, A. (1988). Teachers' theories about children's learning. In J. Calderhead (Ed.) Teachers' Professional Learning. (pp. 128-145). New York: Falmer.

Berman, P. & McLaughlin, M. (1977). Federal Programs Supporting Educational Change. Vol. VII: Factors Affecting Implementation and Continuity. Santa Monica: Rand Corporation.

Cobb, P., Wood, T. & Yackel, E. (1990). Classrooms as learning environments for teachers and researcher. In R. Davis, C. Maher & N. Noddings (Eds.) Constructivist Views on the Teaching and Learning of Mathematics. (pp. 125-146). Reston, VA: National Council of Teachers of Mathematics.

Doyle, W. (1985). Content Representation in Teachers' Definitions of Academic Work. Austin: Research and Development Center for Teacher Education, University of Texas at Austin.

Doyle, W. & Ponder, G. (1977). The practicality ethic in teacher decision-making. Interchange, 8(3), 1-12.

Grimellini Tomasini, N. & Pecori Balandi, B. (1988). Conceptual Change and Science Teacher Training: A Constructivist Perspective. Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Hall, G. & Loucks, S. (1978). Teacher concerns as a basis for facilitating and personalizing staff development. Teachers College Record, 80(1), 36-53.

Leiberman, A. & Miller. L. (1984). School improvement: Themes and variations. Teachers College Record, 86(1), 4-19.

McDiarmid, G. (1990). Challenging prospective teachers' beliefs during early field experience: A quixotic undertaking? Journal of Teacher Education, 41(3), 12-20.

Richardson, V. (1990). Significant and worthwhile change in teaching practice. Educational Researcher, 19(7), 10-18.

Richardson, V. (1992). The agenda-setting dilemma in a constructivist staff development process. Teaching & Teacher Education, 8(3), 287-300.

Schon, D. (1983). The Reflective Practitioner. New York: Basic Books.

Schram, P., Wilcox, S., Lanier, P., Lappan, G., & Even, R. (1988). Changing Mathematical Conceptions of Preservice Teachers: A Content and Pedagogical Intervention. Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15, 4-21.

Straus, A. & Corbin, J. (1990). Basics of Qualitative Research. Newbury Park: Sage.

Swanson-Owens, D. (1985). Identifying Natural Sources of Resistance: A Case Study Analysis of Curriculum Implementation. Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Thompson, A. (1984). The relationship of teachers' conceptions of mathematics and mathematics teaching to instructional practice. Educational Studies in Mathematics, 15, 105-127.

Wood, T., Cobb, P. & Yackel, E. (1991). Change in teaching mathematics: A Case study. American Educational Research Journal, 28(3), 587-616.